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# BEYOND BOUNDARIES: UNLEASHING 6G'S TRANSFORMATIVE WAVE IN INDIA

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**Abstract**

*India is a developing country in terms of both technology and infrastructure. Since India is already pursuing its research in 5G and is already using the 4G network, but the problem that Indian citizens have with the current mobile network infrastructure can't be properly solved even by the upcoming 5G, so here we need to think about why we are talking about 6G in such an early stage. Not only because of the great network bandwidth and low latency of the features of 6G, or why we say that 6G will be a game changer for Indian mobile network infrastructure because of features like maximum spectral efficiency that's up to 1000 km/hours and peak data rate that's up to 1 Tbps, which is twice that of 5G and nearly quadruple that of 4G. In this paper, we discussed what the main advantages are. What are the problems faced by Indians, why these problems are caused, and how 6G can solve them? We also provide the questions that we asked the people (mainly the youth of India). In addition, our paper also suggests a project idea that provides a technological solution to teachers' and professors' wasted time at schools or colleges attending this conference.*

**Keywords:** High-Performance Computing (HPC) Nexus, Internet of Things (IOT), MIMO, 6TH Generation, Low Latency, Network Bandwidth.

## I. Introduction

In this technology-dominated world, the progress of wireless communication has indeed played an important role in shaping today's world. To enable people to experience the transformative benefits that 6G technology will bring to India, paving the way for cross-border connectivity and innovative opportunities in the traditional systems space (XXXVIII). From 1G through to 5G: Journey: Exponential increases in speed, latency, and connectivity (XLIII). However, as we are now entering the era of 6G, discourse is shifting from alterations to changes that would redefine wireless communication itself (XXVII). The sixth generation is not just about velocity. It means

a system beyond terahertz frequency, machine intelligence, and holographic communications, indicating an indeterminate future of connectedness. No doubt, in a country as vast and diverse as India, the need to be ahead of others in telecommunications cannot be overemphasized (XV). The road towards 6G is vital to tackling the unique problems and prospects of India's technological odyssey. Nevertheless, this technology would have a profound impact on every Indian citizen, from city dwellers to farmers living in remote areas (XX). However, connecting all devices at all times through wireless connections that are even faster than we can imagine, will open up new vistas for humanity (Yadav & Agarwal, 2021). How does the digital world look in the 6G era? This chapter seeks to explore the potential of 6G to change our perception of digital experiences, ranging from augmented reality encounters to advanced machine applications (XXXII). For instance, with smart cities and Industry 4 coming into play across India, one would not underestimate the necessity of the connectivity provided by 6G to foster advancements across different sectors. [X] There is also an outline of how various aspects of Indian society may be reinvented using the expected applications of the sixth-generation network [XLV]. Whether it's revolutionizing healthcare delivery, enhancing agricultural practices, or catalyzing economic growth through the Internet of Things (IoT), the versatility of 6G positions it as a cornerstone for addressing the evolving needs of a rapidly advancing nation [XXXVI]. Our paper has the following sections:

The first section is about what the basic need of 6G is, why we need it, and what the importance of 6G is over other networks. After these, we discussed the challenges faced by the people of India due to the current network, which comprises problems in the sectors of health, finance, defense, and education. Then we proposed the idea of how we can use 6G for attendance so that it can save time for both teachers and students. After this, we listed all the questions asked in the survey with the graphical statistics that we received. And at the end, we concluded our paper.

## II. Understanding the Need for 6G Technology

As each new generation of telecommunication evolves, there are transformative breakthroughs [XLII]. Although we are embracing 5G's innovations today, 6G is already lurking on the horizon. Understanding what 6G technology needs necessitates a more subtle examination of the growing demand for an interdependent world as a whole (XIV). Apart from speed and connectivity, 6G imagines an era where never-before-experienced levels of data exchange, ultra-low latency, and novel applications will merge to redefine what is technologically possible [II]. This dive into the world of 6G demands that we understand how changing connectivity and future developments in society or industry will shape our lives in yet unexplored patterns [VII]. Some major reasons why there is high demand for it are as follows:

- Technological Advancements:
- Edge Computing Imperative:
- Internet of Things (IoT) support:
- High Performance Computing (HPC) Nexus:

• Key Players in 6G Development:

• Global Research Initiatives:

• Country-Specific Involvement:

• Hexa-X and Global Collaboration:

• Academic Contributions:

**Table 1: why do we need 6G (difference between 6G,5G, and 4G)**

| Core concept | 4G | 5G | 6G |
|---|---|---|---|
| Peak data rate | 1Gbps | 10Gbps | 1Tbps |
| (E2E) End-to-end latency | 100ms | 10ms | 1ms |
| Maximum spectral efficiency | 15 bps/Hz | 30bps/Hz | 100bps/Hz |
| Mobility support | Up to 350 km/hour | Up to 500 km/hour | Up to 1000 km/hour |
| Satellite integration | NO | NO | fully |
| AI | NO | PARTIAL | FULLY |
| AUTONOUMUS VEHICLE | NO | PARTIAL | FULLY |
| XR | NO | PARTIAL | FULLY |
| HAPTIC COMMUNICATION | NO | PARTIAL | FULLY |
| THz communication | No | Very limited | Widely |
| Service level | Video | VR, AR | Tactile |
| Architecture | MIMO | Massive MIMO | Intelligent surface |

**III. Now that we have discussed the advanced feature of 6G so let's move towards the problem faced due to the current network:**

India, being the second-largest country with 496.50 million subscribers to mobile networks, had to face a large number of problems due to bad network bandwidth. One of the major issues facing the Internet segment in India is the lower average bandwidth of broadband connections compared to that of developed countries.

(src: https://en.wikipedia.org/wiki/List_of_mobile_network_operators)

The basic problems that we discussed here that are faced due to the current network in India are:

- Education sector
- Hospitals
- Financial sector
- Defence sector

**Navigating Educational Challenges in India's Network Infrastructure: A Glimpse into the Potential Role of 6G**

India's education system has completely changed with digital technologies. During the COVID crisis, all schools and colleges were closed due to lockdown and were facing issues with online classes due to network infrastructure, which put the quality and access to education at stake. The most common problems faced by students during this time were:

**• The limited connectivity of rural areas:**

Students in rural areas were facing a main problem due to the limited reach of the network in those areas. As a result, this makes it difficult for students living in far-flung locations to benefit from online educational resources and interactive learning experiences.

**• Internet Bandwidth Limitation and Unreliable Connectivity:**

In urban areas, the networks are lagging and the speed of wi-fi is low, resulting in problems for online classes such as the lagging of video during online classes or the joining or rejoining of the internet..

**• Discriminatory Access to Educational Resources:**

However, this leads to uneven opportunities for people belonging to different socio-economic backgrounds since unprivileged ones lack equal chances of getting a good quality of education compared to their privileged counterparts, who work under more advanced conditions. [XXXIII]

**The Potential of 6G in Mitigating Educational Challenges:**

**• Ultra-Reliable Low Latency Communication (URLLC):**

6G technology is expected to provide ultra-reliable, low-latency communication, ensuring seamless connectivity even in remote areas. This can significantly enhance the delivery of real-time interactive educational content and bridge the digital divide. [XXIV]

**• High Bandwidth and Enhanced Data Rates:**

The increased bandwidth and data rates offered by 6G can address the current limitations, allowing for high-quality video streaming, virtual reality (VR) experiences, and other data-intensive educational applications [XXX].

**• Integration of Artificial Intelligence (AI) in Education:**

6G's support for AI applications can revolutionize personalized learning experiences, adaptive assessments, and intelligent tutoring systems, catering to the diverse learning needs of students [V].

Unravelling India's Healthcare Challenges: A Network Perspective and the Promise of 6G

Challenges in India's Health Sector:

**•Late Reports:**

Due to the current network infrastructure, there is a lag in report generation, which also lags in the treatment of patients, which might also result in the death of patients.

**• Data Security Concerns:**

There could be a breach of data, which can also result in the loss of sensitive information about patients, which can lead to crimes.

**• Remote Monitoring Limitations:**

The ability to remotely monitor patients with chronic conditions is hindered by network constraints. Research highlights the challenges in real-time data transmission that limit the effectiveness of remote patient monitoring systems. [XXXI]

**The Promise of 6G in Healthcare:**

**Ultra-Reliable Low-Latency Communication (URLLC):**

6G technology promises ultra-reliable, low-latency communication, a critical feature for real-time healthcare applications. This can significantly enhance the responsiveness of telemedicine services and enable seamless remote monitoring.

**• High-Resolution Imaging and Virtual Reality (VR):**

The higher bandwidth and data rates of 6G networks can facilitate high-resolution medical imaging and virtual reality applications in healthcare. This can revolutionize diagnostic capabilities and medical training.

**• Edge Computing for Decentralized Healthcare:**

6G introduces advanced edge computing capabilities, enabling decentralized healthcare applications. This can enhance data processing at the edge of the network, reducing latency and improving the overall efficiency of healthcare services.

**Enhancing India's Defense Sector: The Current Network Challenges and the Promise of 6G Technology**

India's defense sector is at the forefront of safeguarding national security, and its effectiveness relies heavily on robust communication networks. However, the existing network infrastructure poses significant challenges that can impact the efficiency and responsiveness of the defense forces. This article delves into the issues faced by India's defense sector concerning the current network infrastructure and explores how the advent of 6G technology holds the potential to address these challenges.

**Challenges in India's Defense Sector Network:**

**• Security and reliability:**

The defense sector demands highly secure and reliable communication networks. However, existing networks face cybersecurity threats, compromising sensitive information. Strengthening security measures is crucial to safeguarding critical defense communications. [XLII]

**• Limited bandwidth and latency:**

Defense operations require real-time communication and data transfer. The current network infrastructure often struggles with limited bandwidth and high latency, hindering the swift exchange of information between different units and command centers. [XIX].

**•Interoperability Issues:**

The diverse range of communication technologies used in the defense sector can lead to interoperability challenges. Seamless communication between various platforms, such as land, sea, and air, is essential for coordinated and effective defense operations. [XXXVII]

**India's Financial Sector: Navigating Network Challenges and the Promise of 6G**

India’s financial sector is facing a wide range of problems that arise from the current network infrastructure in a time where digital transactions and online banking are dominating. When digital financial activities have exploded in the country, activities such as latency, limited connectivity, and security issues have hampered the smooth delivery of financial services. This article discusses these challenges.

**Current Network Challenges in India's Financial Sector:**

**• Latency and Transaction Speed:**

The latency in the existing network infrastructure often results in delayed transaction processing, impacting the efficiency of financial operations. This issue is particularly pronounced during peak hours when the network experiences high traffic. It can also cause problems in online transactions.

**•Security Concerns:**

The financial sector is a prime target for cyber threats, and the current network infrastructure in India may not provide the level of security required to safeguard sensitive financial data. Instances of fraud and data breaches are on the rise, necessitating robust security measures. Which could also lead to cybercrime and terror funding.

**The Promise of 6G Technology:**

The potential of the next generation of wireless communication technology, 6G, to address the challenges faced by India's financial sector is limitless. The subsequent points will highlight how 6G can reduce these problems:

**•Ultra-Low Latency:**

6G technology is anticipated to provide ultra-low latency, ensuring near-instantaneous transaction processing. This improvement would significantly enhance the speed and efficiency of financial transactions, reducing delays and improving the overall user experience.

**•Enhanced Security Measures:**

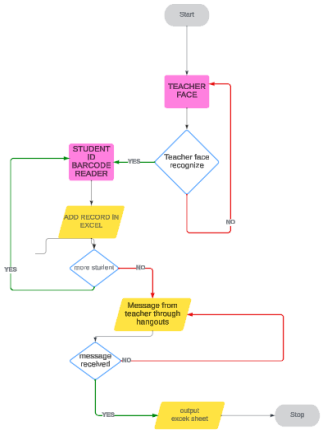
With an increased focus on security features, 6G is expected to offer advanced encryption protocols and cybersecurity measures. This heightened security will help fortify the financial sector against evolving cyber threats and ensure the integrity of financial transactions.

• **Extended Connectivity:** 6G aims to provide broader and more reliable connectivity, reaching even the most remote areas. This expansion of network coverage would facilitate financial inclusion, allowing individuals in underserved regions to access digital financial services seamlessly.

**6G IN BIOMETRIC ATTENDANCE SYSTEM**

Just think of a device that can save the time that both teacher and student spend during attendance. We proposed a device that uses 6G, biometrics, a QR scanner, and face-reco algorithms for taking attendance, saving time for both teachers and students. First, the device scans the teacher's face, creates a new spreadsheet with the name of the teacher, time stamp, and date, and then starts scanning the barcode on the student ID card and saves that student roll number in that spreadsheet with the time he entered. After the completion of all students, it will wait for teachers' messages through hangouts. If the teacher sends the message, it will close the attendance and send the spreadsheet to the teacher through email. This will help to save time that's wasted during attendance, and teachers can use that time for teaching.

**FLOWCHART :**





***PICTORIAL REPRESENTATION :***

**Fig. 1.** How does our model work

**Questions asked in the survey from common people**

Q1) Are they satisfied with the speed of the network they are using?

Q2) Are 4g/5g packets sent at a regular time independently from the uplink?

Q3) How much time does their net take to download a file of 5-10 MB?

Q4) Is there any lagging of net?

Q5) Which network company do they use?

Q6) In what ways has the network technology (4g, 5g) influenced their usage of specific applications or services?

Q7) In what ways can 6g be used to develop the defense sector?

Q8) In what ways can 6g be used to develop the education sector?

Q9) In what ways can 6g be used to develop the health sector?

Q10) in what ways can 6g be used to develop the finance sector?

## IV. Results and Discussion :

- **Output of the survey conducted (answers to few questions)**

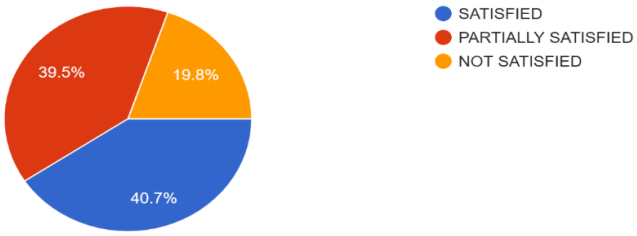



**Fig. 2. a.** Responses of are people satisfied with the speed of the network

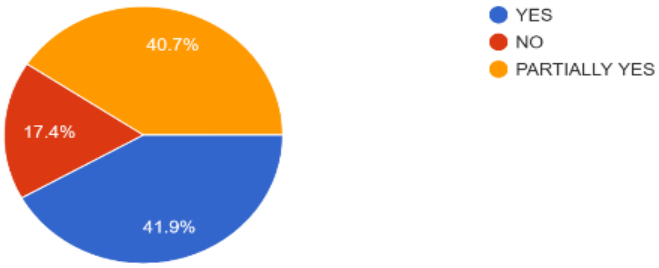



**Fig. 2. b.** Response of are 4g/5g packets sent on a regular time

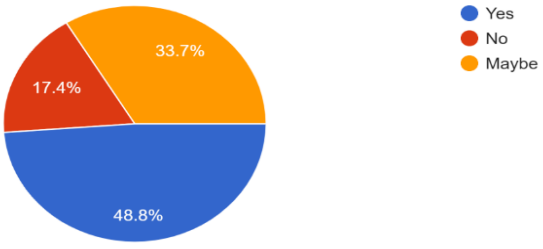



**Fig. 2. c.** Count of is there any lagging of net

- **Discussion on the solution provided:**

The solution resulted in a decrease in the proxy rate of attendance in classes and also reduced the time wasted during the old traditional method of attendance.

## V. Conclusion

BEYOND BOUNDARIES: Revealing the Transformative Wave of 6G. Our country is moving forward at a rapid pace, but we must keep up with it by developing our technology and networks. As India eagerly prepares to embrace this next generation of wireless technology, the path forward lies in delicately navigating through infrastructure development intricacies, regulatory frameworks, and international collaborations. In this unfolding narrative, strategic partnerships and a holistic approach become the guiding threads, presenting India with a unique opportunity to harness 6G. This new network can unlock for our country fresh dimensions of innovation. Give our country wings that can propel the country into a digitally advanced future. There are many pieces required to make this happen, which include components, hardware, protocols, and standards that work together to have seamless communication between different devices. Understanding what makes up a network has become an essential ingredient given that connectivity and data exchange have become vital systems in everyday life for survival in the digital age. Basically, what we do primarily shows how a network works. What should one understand about networking? The understanding reveals how to create a simple 6G-based network. What is better about 6G compared to other networks? Then we come across the problem faced by people in India with the current network structure. We discuss here four main problems (healthcare, education, finance, and defense sectors) and try to give a possible solution for them. Our paper additionally offers a technology-driven approach to resolve the issue or alter the traditional mode of attendance in Indian subcontinent schools and colleges. It can also save the time of attendance and make sure that a proxy student's absence can't occur.

## Conflict of Interest:

The author declares that there was no conflict of interest regarding this paper.

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